

REPORT
OF THE
RAILWAY ELECTRIFICATION
COMMITTEE
(1927)



LONDON :

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MINISTRY OF TRANSPORT

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MINISTRY OF TRANSPORT.

RAILWAY ELECTRIFICATION COMMITTEE (1927).

CONSTITUTION.

Chairman:

Colonel Sir John W. Pringle, C.B., M.Inst.C.E., M.Inst.T., etc., Chief
Inspecting Officer of Railways, Ministry of Transport.

Members:

Sir John A. F. Aspinall, M.Inst.C.E., M.I.Mech.E., M.I.S.I., D.Eng., etc.
Mr. A. R. Cooper, M.Inst.C.E., M.I.E.E., M.Inst.T., Chief Engineer,
London Electric Railways.

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M.Inst.T., Electrical Engineer, L.M. & S. Railway.

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Sir Alexander Gibb, G.B.E., C.B., M.Inst.C.E., M.I.Mech.E., M.Inst.T.

Mr. H. N. Gresley, C.B.E., M.Inst.C.E., M.I.Mech.E., M.Inst.T., Chief
Mechanical Engineer, L. & N.E. Railway.

Mr. Herbert Jones, M.I.E.E., Electrical Engineer, Southern Railway.

Mr. C. H. Merz, M.I.E.E.

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M.Inst.T.

Mr. Roger T. Smith, B.Sc., M.Inst.C.E., M.I.Mech.E., M.I.E.E., President
Inst.T.

Sir John Snell, G.B.E., M.Inst.C.E., M.I.E.E., Chairman, Electricity
Commission.

Secretaries:

Mr. T. L. Paterson, M.Inst.T.	} Ministry of Transport,
Mr. C. Tilden Smith	
	7, Whitehall Gardens, S.W.1.

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MINISTRY OF TRANSPORT.
RAILWAY ELECTRIFICATION COMMITTEE (1927).

Ministry of Transport,
7, Whitehall Gardens,
London, S.W.1.

23rd July, 1928.

To Lieut.-Colonel the Right Hon. Wilfrid Ashley, M.P.,
Minister of Transport.

SIR,

I have the honour to forward the attached Report, setting forth the Conclusions and Recommendations of the Railway Electrification Committee (1927) in regard to the matters indicated in the terms of Reference which accompanied their Appointment.

In all recommendations, except three, the conclusions of the Committee are unanimous. An Addendum by the dissentient Member in regard to the three matters referred to is attached to this Report.

I have the honour to be,

Sir,

Your obedient Servant,

(Signed) J. W. PRINGLE (Chairman).

REPORT.

1. The Railway Electrification Committee was appointed by the Minister of Transport on the 11th November, 1927, with the following terms of reference:—

To review the recommendations made by the Electrification of Railways Advisory Committee, 1921, and to report what modifications, if any, should be made in these recommendations, having regard to the developments which have taken place since that date.

2. The terms of reference (March, 1920) of the Electrification of Railways Advisory Committee, 1921, were as follows:—

“To consider and advise:—

I.—Whether any regulations should be made for the purpose of ensuring that the future electrification of railways in this country is carried out to the best advantage in regard to interchange of electric locomotives and rolling stock, uniformity of equipment and/or other matters.

II.—If any such regulations are desirable, what matters should be dealt with, and what regulations should be made.

III.—How far it is desirable, if at all, that railways or sections of railways already electrified should be altered so that they may form parts of a unified system.”

These terms of reference were extended in October, 1920, to include:—

“IV.—Whether any regulations should be made to limit the drop of potential in an uninsulated return conductor on electrically operated railways.

V.—If any such regulations are desirable, what limits these should impose, and under what conditions.”

3. The Railway Electrification Committee held their first meeting on the 28th November, 1927, and have held 23 sittings.

4. The Committee have heard the views of Sir Herbert A. Walker, K.C.B., General Manager, Southern Railway, and Chairman (1928) of the General Managers' Conference of the Railway Companies' Association, and of Captain G. R. S. Wilson, R.E., representing the War Office, in respect of the degree of interchangeability of electric rolling stock which it is desired should be maintained in the future.

They have also received evidence on technical matters and cost of equipment from Mr. P. S. Turner (Metropolitan Vickers Co.) and Mr. H. N. Spurborg (British Thomson-Houston Company), as representing the Electrical Manufacturers.

5. During the past seven years up to March, 1928, the following additional single-track mileage has been electrified on the direct current system and at the under-mentioned sub-station bus-bar voltages:—

(1) Voltage 650—		mileage.	
Southern Railway	Western Section ... ..	...	67
”	” Central Section ... ..	...	91
”	” Eastern Section .. ...	...	250
			408
(2) Voltage 600—		m. chs.	
(a) L.E. Railway	Edgware Extension ...	10	20
	Camden Extension ...	2	17
	Kennington Extension	3	26
(b) C. & S.L. Railway	Morden Extension ...	10	52
(c) District Railway	Widening		79
(d) L. & N.E. and Metro-	Watford Extension ...	5	0
	politan Joint Railways.		5
(e) L.M. & S. Railway	Watford Extension to	4	40
	Croxley Green and		
	Rickmansworth.		
			4½
			445

6. The total single-track mileage of electrified railways to date in this country is approximately as follows :—

Direct Current.		Alternating Current.	Total.
Low Voltage.	High Voltage.		
1,257 m.	77 m.	151 m.	1,485 m.

The Southern Railway has, however, decided to substitute the low voltage D.C. third rail system for the whole of their existing single phase A.C. overhead system, viz., 132 miles, on the Central (L.B. & S.C.) Section. It is estimated that this substitution, together with the electrification of further sections of line now worked by steam, making 147 miles in all, will be completed within 12 months.

By 31st March, 1929, therefore, although the whole of the overhead single phase equipment on the Central Section of the Southern Railway will not have been actually removed, the total single-track mileage of electrified railways will be approximately as follows :—

Direct Current.		Alternating Current.	Total.
Low Voltage.	High Voltage.		
1,404 m.	77 m.	19 m.	1,500 m.

7. The Committee having viewed in the light of present day conditions the recommendations made by the Electrification of Railways Advisory Committee of 1921, desire :—

In respect of Reference I (1921 Report), to endorse the opinion of the previous Committee that :—

“ In order to ensure the future electrification of railways in this Country being carried out to the best advantage in respect to the matters indicated in the Reference, it is desirable that certain general regulations should be made for observance by the Railway Companies when electrifying their lines.

These regulations should be directed specially to ensuring standardisation of those methods and appliances which are likely to prove the most satisfactory under British conditions.

Such regulations should put no avoidable difficulties in the way of the adoption in future, with the approval of the Minister, of any improvements in methods or appliances which may from time to time become available with increasing knowledge and experience.”

8. The decision of the Southern Railway to abandon the single-phase alternating current system on their Central (L.B. & S.C.) Section enables the Committee to simplify their recommendation in respect of the type of current for electrification.

In respect of standard voltages, however, the fact has to be taken into account, that a considerable mileage has now been electrified with a sub-station bus-bar voltage of less than 750. The Committee realise further that railway companies, who have not so far electrified their lines to any large extent, should not be debarred from adopting a bus-bar voltage of 750. Although no extension on the higher voltage (1,500) has been made, the Committee still consider that the higher voltage must be retained, especially for main line long distance working. They therefore now recommend two “ maximum ” standards, one for higher and one for lower voltage.

The circumstances referred to above have led the Committee to prescribe two standards of voltage instead of one, and to recommend two standard methods of collection, one for the higher and one for the lower voltage.

9. In respect of Reference II (1921 Report), they therefore recommend that regulations should be issued as follows :—

A. Type of current.—Direct current (as recommended in 1921 Report) should be used on all future electrification, or extensions of existing electrification.

B. Voltage—The maximum standard voltages at sub-station bus-bars for all future electrification should be—

(1) Higher	...	...	...	...	1,500
(2) Lower	...	...	...	...	750

Provided that a railway company should not necessarily be debarred from applying to the Minister of Transport for approval to use a sub-station bus-bar voltage of 3,000.

C. Standard Voltage of Motors—Motors for the higher voltage system, whilst being designed to give the best results at the voltage at which they are to work, should be capable of operating satisfactorily at 1,500 volts.

Similarly motors for the lower voltage system, whilst being designed to give the best results at the voltage at which they are to work, should be capable of operating satisfactorily at 750 volts.

D. Generation and Frequency—The generation of electrical energy for direct current lines should be by alternating current 3 phase 50 cycles per second, and at such voltage as may be found desirable in each case, subject to the provisions of the Electricity (Supply) Acts.

10. The Committee also recommend that the standards for all future electrification should be:—

E. Collection.

(1) *For the higher voltage*, overhead collection with uninsulated return by the running rails.

Provided that the Minister of Transport may approve third rail collection on any railway or part of a railway where technical structural or economic conditions, having due regard to safety, justify its adoption.

(2) *For the lower voltage*, third rail collection with uninsulated return by the running rails.

Provided that:

(i) The use of an uninsulated return as the standard system should not prohibit the use of special rails, whether insulated or not, as feeders.

(ii) An insulated fourth rail should be permitted for Tube lines, and for limited extensions of existing systems which employ an insulated return.

F. Contacts.

(1) *For higher voltage*.—Under contact with overhead conductor.

Provided:

(i) That if the Minister of Transport at any time consents to an installation of third rail collection for the higher voltage, the method of contact (under or top) shall then be decided by him on merits.*

(ii) That in respect of side contact, this method may be agreed to, as a special case, for any future extensions of the Manchester-Bury line.

(2) *For lower voltage*.—Top contact with rail conductor.

11. Inter-running.

I.—Multiple Unit Stock.

The Committee do not consider it necessary to provide for inter-running by multiple unit stock between higher and lower voltage systems. The inter-running of multiple unit stock between lines employing different voltages, within the higher and lower maximum standards respectively, is provided for by Recommendation C (Standard Voltage of Motors).

II.—Locomotives.

(1) *Structural*.—The Committee in connection with the standardisation of the main dimensions of overhead bow collectors have, with the valued assistance of the Engineering Officers of the Railway Companies, prepared two maximum loading gauges for electric locomotives. These are shown on Drawings Nos. 1 and 2 attached to the Report.

* In such a case, the Committee would be disposed to favour the under contact type of rail, which can be more easily and effectively protected, in order to safeguard workmen or trespassers on the lines, and is also likely to be less affected by ice or snow. They feel however that further trial and experience are necessary to determine whether an under contact rail is feasible in this country, more especially in view of clearance requirements, and for this reason they are not in a position to make any definite recommendation in the matter.

Electric locomotives constructed to No. 1 loading gauge (with a maximum height of 12 feet 8 inches above rail level) will be suitable for inter-running on all British Railways, with the exception of certain sections of line totalling 264 route miles (see Appendix I). They will be suitable, if built to this gauge, for use on the important section of line known as the Metropolitan Widened Lines, which connect the Northern with the Southern railways. Such locomotives will have a scope of operation covering 19,952 route miles out of a total of 20,216.

In order to take advantage of the higher loading gauges of the London, Midland and Scottish, the London and North Eastern, the Great Western, and the London to Brighton section of the Southern Railway, No. 2 gauge (with a maximum height of 13 feet 2 inches above rail level) has been prepared. Electric locomotives constructed to this gauge will have a scope of operation covering 13,327 route miles.

As far as the lower portion of these loading gauges is concerned it will be necessary for inter-running purposes, in connection with shoe collector gear, to rearrange structures to provide the clearances shown on Drawings Nos. 1 and 2. Attention is also drawn in this connection to the following observations:—

(a) A minimum clearance between rails of 4 inches above rail level must be provided under conditions of maximum wear.

(b) In the case of electric locomotives designed for general inter-running, it may be necessary for a fourth-rail shoe to be provided, which, in the normal position, must be within the loading gauge, and means must be provided for depressing this shoe when working over fourth rail sections of railway.

(c) In the event of certain structures, such as the Forth Bridge, having physical obstructions which cannot, for financial or other reasons, be removed, it will also be necessary for the positive collector shoe to be so designed that it can be lifted up so as to give a clearance of not less than six inches above rail level.

Maps of the London area, England and Wales, and Scotland, respectively, are attached to this Report. These maps show by colouration the lines over which electric locomotives conforming to loading gauges Nos. 1 and 2 respectively can be operated, as well as the sections of line (264 route miles in all) over which structural conditions do not permit the use of electric locomotives constructed to the full dimensions of either No. 1 or No. 2 gauge (see also Appendices I, II, and III).

The Committee recommend:—

- G (i)** That all electric locomotives should in future be constructed within one or other of the standard loading gauges shown on Drawings Nos. 1 and 2.

The standard type and dimensions of overhead current collector for all future electric locomotives should be as set out on Drawing No. 3.

(2) *Electrical.*—As regards electrical equipment, etc., inter-running of locomotives can be most economically provided for by installing (on first construction) low voltage motors, with the provision for working these in series-pairs when on the higher voltage and a motor generator or its equivalent for auxiliary services. The Committee understand from Manufacturers' evidence that the additional cost in contactor switches and change-over arrangement, in the case of locomotives designed for the higher voltage so that they may work without loss of efficiency on the lower voltage, would not be considerable. On the other hand, in the case of locomotives designed for working on the lower voltage, the evidence showed that the additional cost to make them available for working on the higher voltage would be substantial.

They therefore recommend:—

- G (ii)** That electric locomotives intended for inter-running should be equipped with lower voltage motors designed to work on the higher voltage with series—parallel switching and the necessary equipment for dual working.

It will also be necessary that such locomotives be provided with the standard type of bow collector for overhead line collection and with suitable shoe collector gear for rail collection.

12. The Committee, in connection with the interchangeability of electric locomotive stock and the fact that at the present moment there is very little electrical working between any of the main line railway companies, and that many years may elapse before such electric working is required, are of opinion that at the present time Regulation G (ii) recommended in paragraph 11 should not be enforced. They consider that for many years sufficient interchangeability, so far as national or other purposes are concerned, must necessarily be provided for by change of locomotives. They hold the view that action in the direction of the above-named Regulation need not be taken until, in the case of each railway company, the proportion of one-third of the locomotives owned have been replaced by electrically propelled machines. The question of calling for standard electrical equipment to provide for inter-running should then be considered by the Minister of Transport.

13. In respect of Reference III (1921 Report).—In view of the decision of the Southern Railway to discontinue, in favour of direct current, the single phase alternating current system now in existence on the Central section (London, Brighton and South Coast) of their railway, the Committee do not think it necessary, in respect of any alteration of existing electrified railways, to refer to any other than the Heysham, Morecambe and Lancaster section of the London, Midland and Scottish Railway, which is now electrified on an alternating system. They consider that on this section the A.C. System will eventually be abandoned.

14. **Standardisation of Third rail and overhead Equipment.**—In order to secure interchangeability of running the Committee endorse the views of the Committee of 1921 as regards standardisation of track equipment in respect of (1) rail collection, and also, with certain amendments, of (2) overhead collection of current, as set forth in paragraphs 4, 5 and 6 of the earlier report. Their recommendations will be found set out in detail in paragraph 18.

15. With regard to the extended References IV and V (1921 Report), the Committee after full consideration find:—

(1) With regard to the necessity for protective clauses "for preventing fusion, or injurious electrolytic action, of or on gas or water pipes, or other metallic pipes, structures, or substances," the problem on the railways with their own right-of-way is quite different from that on tramways with tracks laid in the public streets.

It is true that railways operate with higher voltage drops in the track rails than tramways, but this in itself does not necessarily result in higher leakage current, as the important factor of resistance between the track rails and earth must be taken into consideration. Tramway rails are buried in the road surface and their resistance to earth is low, whereas railway rails are laid on sleepers resting on ballast and have very much higher resistance to earth.

Buried metallic systems do not pick up any appreciable current from the earth unless they enter potential gradients from the track rails at some point, or points. These potential gradients usually do not extend a great distance from the rails, or from metallic connections to the rails, and as railways have their own right-of-way, the pipes and cables of outside parties are seldom in dangerous proximity.

It is to be remembered also that railway companies themselves frequently have extensive pipe and cable systems laid in the neighbourhood of the tracks, and usually in positions where they are much more likely to be subject to damage by electrolysis than the pipes and cables of other parties. Water pipes feeding water troughs or water cranes, and gas pipes for filling the reservoirs on the trains, must of necessity be close to the track and are frequently under it.

Whenever, therefore, conditions on any electrified railway should become such as to produce risk of electrolysis to buried pipes and cables, the railway companies are likely to be the first sufferers and can, therefore, be relied upon to take all reasonable precautions.

The Committee understand that it is the desire of the Minister that railway electrification schemes should not be unduly hampered or rendered economically impracticable by regulations of too stringent a character. Any limitation of

the drop of potential would, in the opinion of the Committee, certainly tend to prevent extensions of electrification. Furthermore, they consider that electrolysis and inductive interference may be due to causes other than drop of potential. For these reasons they support the view expressed by the Committee of 1921, that regulations limiting the drop of potential in an uninsulated return conductor on electrically operated railways are undesirable.

If, however, the issue of some regulations governing the conditions of railways using the track rails for return current is considered necessary from the statutory point of view, it would appear that rules as set out at J in paragraph 19 would sufficiently meet the case. Rules more severe in character might, in their opinion, operate prejudicially against extensions of railway electrification.

(2) These Rules were fully discussed by members of the Committee at a meeting with the representatives of the General Post Office at which Colonel T. F. Purves (Engineer-in-Chief) was present. These gentlemen thought the proposed rules were good in themselves, but that they did not go far enough in the direction of limiting the drop of potential in the return. They alleged that several cases of electrolysis to and interference with Post Office cables by stray currents had come to their notice, in the vicinity of recently electrified lines, though no trouble had been experienced from earlier electrifications (1916). They considered that further trouble was likely to occur unless the current in the return rail was adequately controlled. It was later suggested in writing by Colonel Purves that a joint investigation should be carried out between representatives of the General Post Office and of the particular railways concerned, and that records should be made, during the hours of maximum traffic, of the drop of potential in the track rails between each negative feeder and a point midway between adjoining negative feeders, together with simultaneous tests of the stray currents in the sheaths of any Post Office cables in the vicinity.

Full consideration has been given by the Committee to the views of the General Post Office, but for the reasons previously stated they consider that a Rule to limit the drop of potential would not be "reasonably practicable." Moreover, voltage drop in the rails is not, in their opinion, the only factor which governs the question of damage or interference.

Summary.

16. The Committee consider (vide para. 7) that certain general regulations, which will ensure standardisation of methods and appliances suitable to British railways, and which will not create avoidable difficulties in the future adoption, with the approval of the Minister of Transport, of any possible improvements, should be made for the observance by the Railway Companies in all future electrification or extensions.

17. The conclusions and recommendations of the Committee, contained in paras. 8 to 12 inclusive, may for convenience be briefly recapitulated :—

A. Type of Current. Direct.

B. Permissible Voltage. Maximum standards at sub-station bus-bars to be :—

(1) Higher Voltage	...	...	...	...	1500
(2) Lower Voltage	...	...	...	...	750

Provided that a Company may apply for approval to use a voltage of 3,000 in special conditions.

C. Standard Voltage of Motors. In future all motors either for higher or lower voltage systems, whilst designed to give the best results at the particular voltage at which they are to work, shall be capable of operating satisfactorily on the higher and lower maximum standard voltages respectively.

D. Generation and Frequency. Alternating current 3 phase 50 cycles per second at such voltage as may be considered desirable—subject to the provisions of the Electricity (Supply) Acts.

E. Method of Collection.

(1) *Higher Voltage* :—Overhead collection, with uninsulated return by the running rails.

Provided that third rail collection may be specially approved in cases where technical, structural, or economic conditions, having due regard to safety, justify its adoption.

(2) *Lower Voltage* :—Third rail, with uninsulated return by the running rails.

Provided that a fourth insulated rail may be permitted for Tube lines, and for limited extensions of systems now employing an insulated return

F. Method of Contact.

(1) *Higher Voltage* :—Under contact with overhead conductor.

(2) *Lower Voltage* :—Top Contact, with rail conductor.

G. Inter-running.

(i) *Structural* :—All electric locomotives to be constructed within one or other of the two loading gauges set out in Drawings Nos. 1 and 2.

(ii) *Electrical* :—Electric Locomotives intended for inter-running to be equipped on first construction with lower voltage motors designed to work on the maximum higher voltage with series-parallel switching, and the necessary equipment for dual working. Standard type (vide Drawing No. 3) of bow collector for overhead collection, as well as suitable shoe collector gear for rail collection, to be provided.

Provided that action in connection with Regulation G. (ii) need not be taken until in the case of each Railway Company the proportion of one-third of the locomotive stock owned has been replaced by electrically driven machines. It will then be advisable for the Minister of Transport to consider the desirability for calling for compliance with this regulation for inter-running.

18. The detailed recommendations referred to in paragraph 14 are as follows :—

H. Standardization of Third rail and overhead Equipment.

(1) *Third rail* :—

(i) Contact surface to be in the horizontal plane (see proviso to Recommendation F (1)).

(ii) The gauge measured between the centre of the horizontal contact surface of contact rails and the gauge line of the nearest rail of the corresponding track shall be 1 foot 4 inches.

(iii) The vertical height of the contact surfaces above the plane of the top table of the running rails shall be—

	<i>inches.</i>
(a) for top contact rails	3
(b) for under contact rails	1½

(iv) The vertical height of the contact rail (including, where required, the protection over the top of the rail) above the plane of the top table of the running rails shall be such as to provide the necessary clearance from the load gauges from time to time in use.

(v) The under contact rail, if employed, shall provide for the engagement of the contact shoe being made from the side nearest to the running rails.

(vi) Above the level of the under contact surface (iii) (b) no part of the contact rail construction shall be at a less distance than 1 foot 1½ inches from the gauge line of the nearest track rail, and below the level of the under contact surface (iii) (b) at a less distance than 1 foot 7½ inches from the gauge line of the nearest track rail.

(vii) The vertical distance between the under side of any contact shoe in the free position and the plane of the top table of the running rails shall not be less than 1½ inches.

Provided that extensions of existing equipments which do not conform to the above recommendations may be approved by the Minister of Transport.

Drawing No. 4 illustrates the position and dimensions of third rail collector. (These are as recommended by the 1921 Committee.)

(2) *Overhead Equipment.*

(i) The standard clearances, after allowance has been made for curvature and super-elevation, including any movements of the live wire or conductors, and lateral movements of the collectors under any circumstances likely to arise, shall be:—

(a) Through tunnels, under bridges, etc., between the maximum load gauge likely to be used on the line and the underside of any overhead live wire or conductor.....normally 10 inches.

(b) Between any part of the structures and the nearest point of any live overhead wire or conductor.....6 inches.

Provided that in cases of exceptional difficulty the above clearances shown in (a) and (b) may be reduced to 4 inches as a minimum.

(c) Between rail level and overhead conductors, the clearance shall be—

	<i>Ft.</i>	<i>Ins.</i>
For normal running conditions	16	0
At accommodation and public road level crossings	18	0
At places where there is a likelihood of men in the conduct of their duties having to stand on the top of the engines or vehicles	20	0

(d) Between any part of the collector gear and any structure 0 3

(ii) The maximum horizontal variation, on either side of the centre line, in the position of the contact wire as constructed shall be:—

	<i>Ft.</i>	<i>Ins.</i>
(a) At a height of 16 feet above rail level	1	0
(b) At a height of 13 feet above rail level	1	6

(iii) The weight and construction of the contact wire and supports shall be suitable for the passage of collectors exerting an upward pressure of from 25 to 40 lbs.

(iv) The width of the renewable contact surfaces of the collectors at right angles to the track shall be 3 feet 10 inches, and the extreme width over the horns of the collectors 6 feet.

Drawing No. 5 illustrates the dimensions referred to.

19. With regard to the extended references IV and V (1921 Committee) the Committee consider that Regulations limiting the drop of potential in uninsulated conductors on electrically operated lines of railway are undesirable.

They suggest that the following regulations may be made with a view to preventing electrolysis and inductive interference from railway electrification:—

J. (a) The Railways shall instal and take steps to keep in good working order proper bonds, designed and arranged to maintain the conductivity of the running rails, and of any supplementary conductors connected to the running rails.

The design of the bonds shall be such that the resistance of a joint, including 3 feet of rail, shall not exceed that of 6 feet of unjointed rail, and the bonded joint shall be maintained so that its resistance, including 3 feet of rail, shall not exceed that of 10 feet of unjointed rail.

From time to time the Railways shall carry out tests to ensure that the above mentioned standards are being maintained.

(b) With the exception of such of the running rails, and of any supplementary conductors laid on the sleepers as form part of the return circuit, together with the bonds of such rails and conductors, all parts of the return circuit extraneous to the rolling stock shall be insulated.

(c) The sub-station negative bus-bars shall not be permanently connected to any earth plate or to any special earthing system.

(d) The return circuit, together with such of the permanent way, signalling and other railway appliances and structures as are in metallic connection therewith, shall be electrically separated, so far as railway construction will reasonably permit, from the general body of the earth extraneous to the railway, and from any system of gas, water, or other metallic pipes or lead-covered or armoured cables belonging to other parties.

(e) Precautions shall be taken, according to the conditions of the site, to prevent any mast carrying contact feeder or transmission lines from acting as a path for earth currents from the railway system.

(f) To avoid injurious inductive effects, the electrical machinery supplying direct current to a third rail or overhead line shall be so designed as to reduce tooth ripples in the direct current voltage to within the limits prescribed by the British Engineering Standard Specifications.

20. The Committee in submitting their report for the consideration of the Minister recommend, further, that in view of future improvements in electrical equipment and design, the above conclusions and recommendations should be reviewed after a period of years, and an opportunity afforded of revising them, if need be.

21. The Committee desire to express their recognition of the work which Mr. T. L. Paterson and Mr. C. Tilden Smith have performed as Secretaries and the valuable assistance which they have given. Since 26th January, 1928, owing to Mr. Paterson's ill-health, Mr. Smith has alone carried out the Secretarial work of the Committee.

Signed

JOHN W. PRINGLE (Chairman).
JOHN A. F. ASPINALL.
ARTHUR R. COOPER.
F. A. CORTEZ LEIGH.
PHILIP DAWSON.
ALEXANDER GIBB.
H. N. GRESLEY.
CHARLES H. MERZ.
P. A. M. NASH.
ROGER T. SMITH.
JOHN SNELL.

THOS. L. PATERSON. } (Secretaries).
C. TILDEN SMITH. }

23rd July, 1928.

ADDENDUM BY MR. HERBERT JONES.

I regret that I cannot see my way to sign the above Report, as I am not in agreement with Recommendations E and F, and am convinced that in the interests of railway electrification under British conditions there should be no departure at the present time from the Recommendations of the Electrification of Railways Advisory Committee, 1921, in respect of the Standardisation of Methods of "Collection" and "Contact," and that no such departure is necessary for inter-running. I am also not in accord with Recommendation G, and am of opinion that in view of probable developments in future, including modifications to loading gauges, the present position would be met by a recommendation that the question of providing electric locomotives for inter-running should be reconsidered when the motive power of one-third of the total number of locomotives in the country is electricity.

With the exception of the three Recommendations mentioned, and any subject matter relating thereto, I am in accord with the conclusions and recommendations contained in the Report.

HERBERT JONES

APPENDIX I.

Particulars of Sections of Line over which the General Inter-running Electric Locomotive (No. 1 Gauge—12 feet 8 inches above rail level) cannot be worked.

Miles. Chains.

<i>Great Western Railway.</i>			
Burry Port and Gwendraeth Valley	32	40	
Liskeard to Caradon	6	0	
Stratton to Highworth... ..	6	0	
<i>London, Midland and Scottish Railway.</i>			
Maryport and Carlisle... ..	42	63	
<i>Southern Railway.</i>			
North Kent East Junction to Plumstead	5	57	
Canterbury to Whitstable	6	1	
Tonbridge to Hastings, Bexhill and Rye	48	19	
Central London	6	70	
City and South London	12	49	
London Electric	31	37	
Metropolitan District	27	66	
Metropolitan and Metropolitan Dist. Joint	2	2	
Liverpool Overhead	6	40	
Sundry Branches	40	0	
Total	264	44	

APPENDIX II.

Particulars of Sections of Line over which the General Inter-running Electric Locomotives (No. 1 Gauge—12 feet 8 inches above rail level) can be worked, but over which the Larger Inter-running Electric Locomotives (No. 2 Gauge—13 feet 2 inches above rail level) cannot be worked.

Miles. Chains.

<i>Great Western Railway.</i>			
Rhymney Bridge to Cardiff	25	11	
Bassaleg Junction (Newport) to Rhymney (Lower)	20	78	
Cardiff to Penarth and Biglis Junction	8	14	
<i>London and North Eastern Railway.</i>			
Great North of Scotland	334	40	
North British	1,377	40	
<i>London, Midland and Scottish Railway.</i>			
Caledonian	1,114	40	
Cockermouth, Keswick and Penrith	30	65	
Furness	158	21	
Glasgow and South Western	493	40	
Highland	506	0	
Portpatrick and Wigtownshire Joint	79	0	
<i>Southern Railway</i>	2,081	32	
Sundry Branches	395	57	
Total	6,625	38	

APPENDIX III.

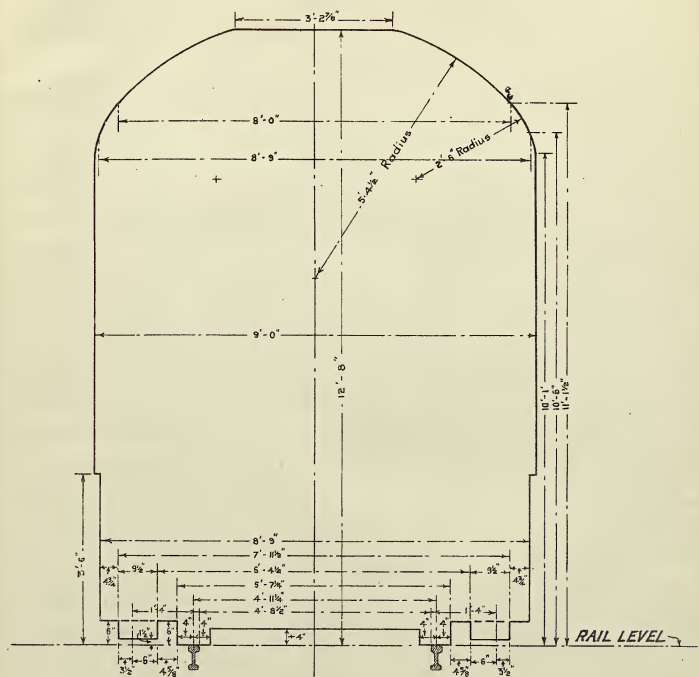
Summary of Route Mileage of Lines, as indicated on the Maps relating to:—

- (a) London Area.
- (b) England and Wales.
- (c) Scotland.

Total Mileage of Lines excluding Isle of Wight (1926 Return)	<i>Miles.</i> 20,216
Mileage of Lines over which 12 feet 8 inches Electric Locomotives <i>cannot</i> be worked, as indicated in RED	264
Mileage of Lines over which 12 feet 8 inches Electric Locomotives can be worked, but <i>not</i> the 13 feet 2 inches Electric Locomotives, as indicated in BLUE	6,625
Mileage of Lines over which both the 12 feet 8 inches and 13 feet 2 inches Electric Locomotives can be worked, as indicated in GREEN	13,327
<i>Therefore—</i>	
Mileage of Lines over which 12 feet 8 inches Electric Locomotives <i>can</i> be worked	19,952

RAILWAY ELECTRIFICATION COMMITTEE, 1927

Drawing N^o 1.



SCALE: 1/2 INCH TO 1 FOOT

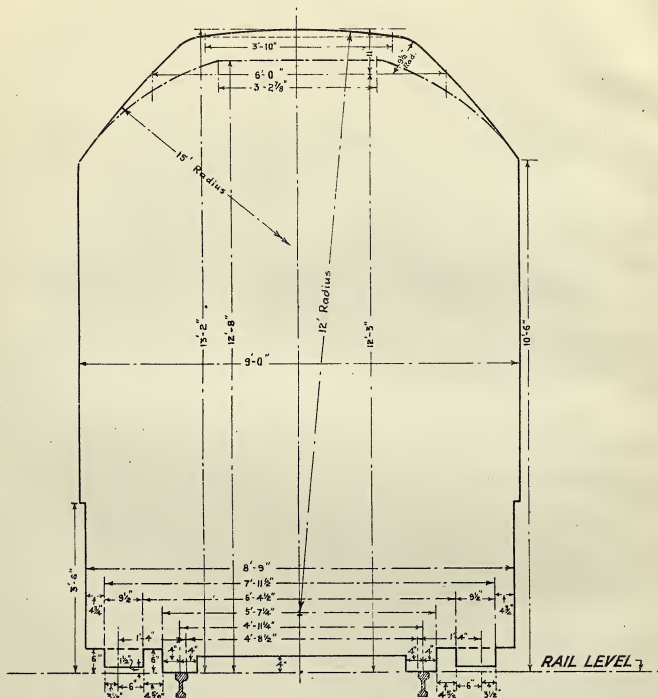
MAXIMUM LOADING GAUGE FOR ELECTRIC LOCOMOTIVES USED FOR INTERRUNNING

*The widths shown above are subject to the length
and wheelbase of the locomotives*

1-6-1928.

RAILWAY ELECTRIFICATION COMMITTEE, 1927

Drawing N^o 2.

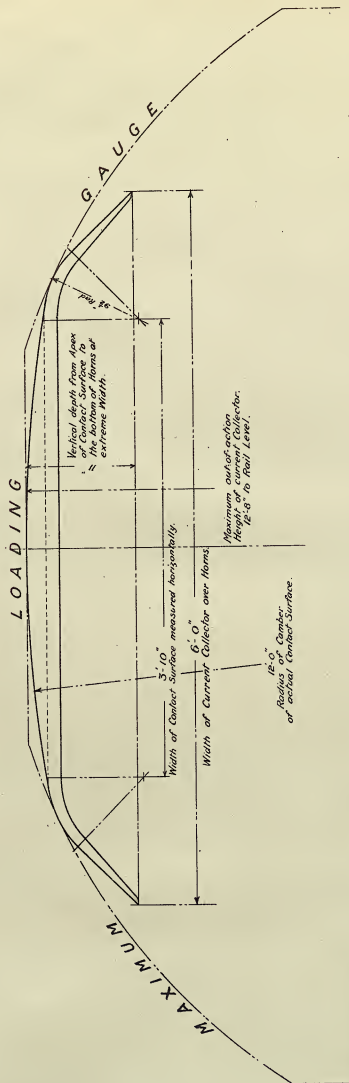


SCALE: 1/2 INCH TO 1 FOOT

MAXIMUM LOADING GAUGE FOR
ELECTRIC LOCOMOTIVES USED FOR
INTERRUNNING ON CERTAIN
SPECIFIED RAILWAYS

*The widths shown above are subject to the length
and wheelbase of the locomotives.*

1-6-1928.



PROPOSED PROFILE OF CURRENT COLLECTOR
FOR ELECTRIC LOCOMOTIVES USED FOR INTERRUNNING.

SCALE:

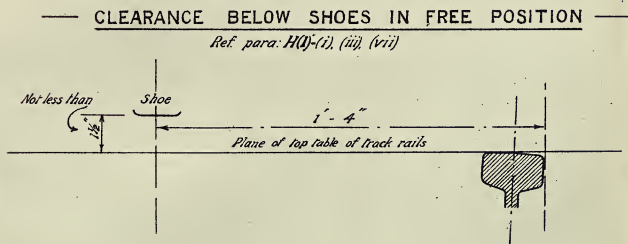
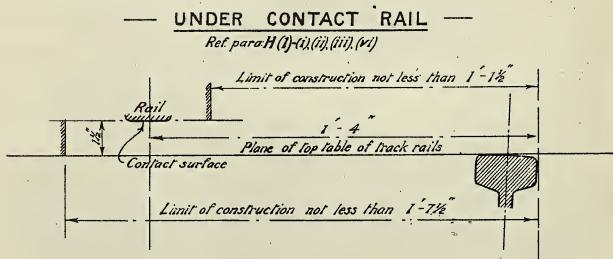
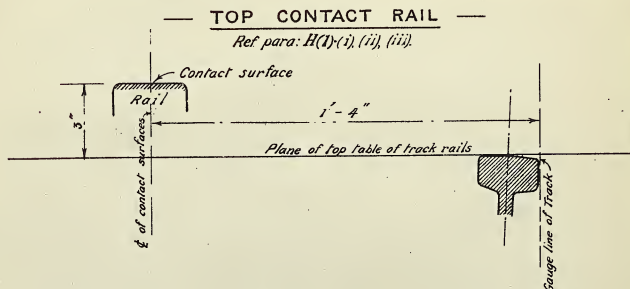


RAILWAY ELECTRIFICATION COMMITTEE, 1927.

Drawing No 4.

STANDARDISATION OF CONTACT RAILS

DIAGRAM ILLUSTRATING RECOMMENDATIONS RELATIVE TO THE POSITION OF CONTACT SURFACES AND CLEARANCES OF CONTACT RAIL AND SHOE CONSTRUCTION.

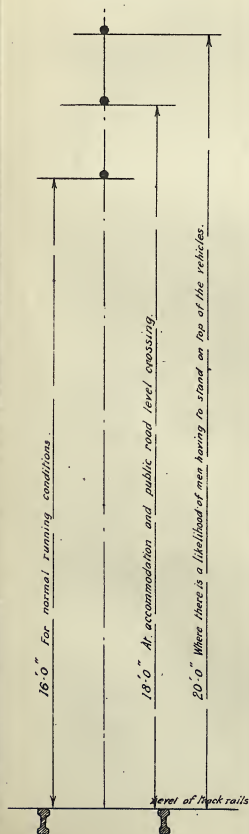


STANDARDISATION OF OVERHEAD CONTACT WIRES

DIAGRAM ILLUSTRATING RECOMMENDATIONS IN RESPECT OF
OVERHEAD CONTACT WIRE AND COLLECTOR GEAR

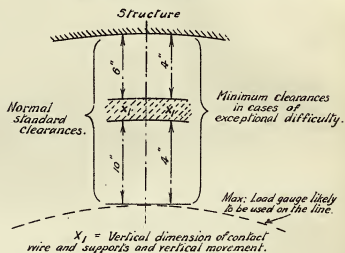
CLEARANCE BELOW CONTACT WIRE AND
SUPPORTS EXCEPT WHERE THE TRACK
PASSES BELOW OVERLINE STRUCTURES.

Ref para: H (2) (i).



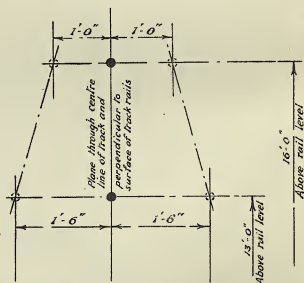
CLEARANCE BELOW & ABOVE CONTACT WIRE & SUPPORTS
WHERE THE TRACK PASSES UNDER OVERLINE STRUCTURES

Ref para: H (2) (i)



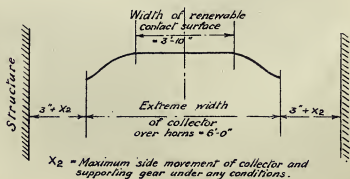
MAXIMUM VARIATION HORIZONTALLY IN THE
POSITION OF CONTACT WIRE.

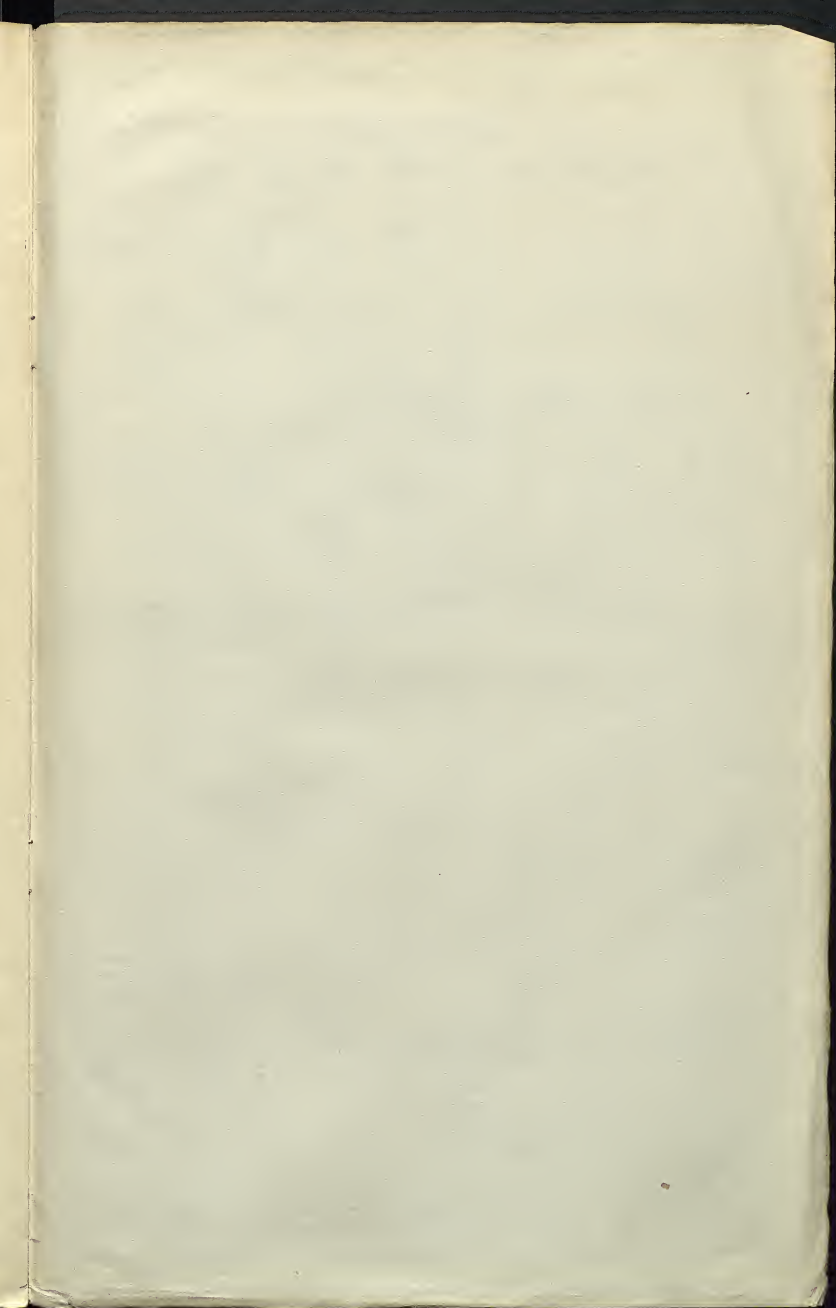
Ref para: H (2) (ii)



LIMITING DIMENSIONS AND SIDE CLEARANCES FOR
COLLECTORS ENGAGING WITH CONTACT WIRE

Ref para: H (2) (i) & (iv).







MAP N^o 1—LONDON AND ITS ENVIRONS.

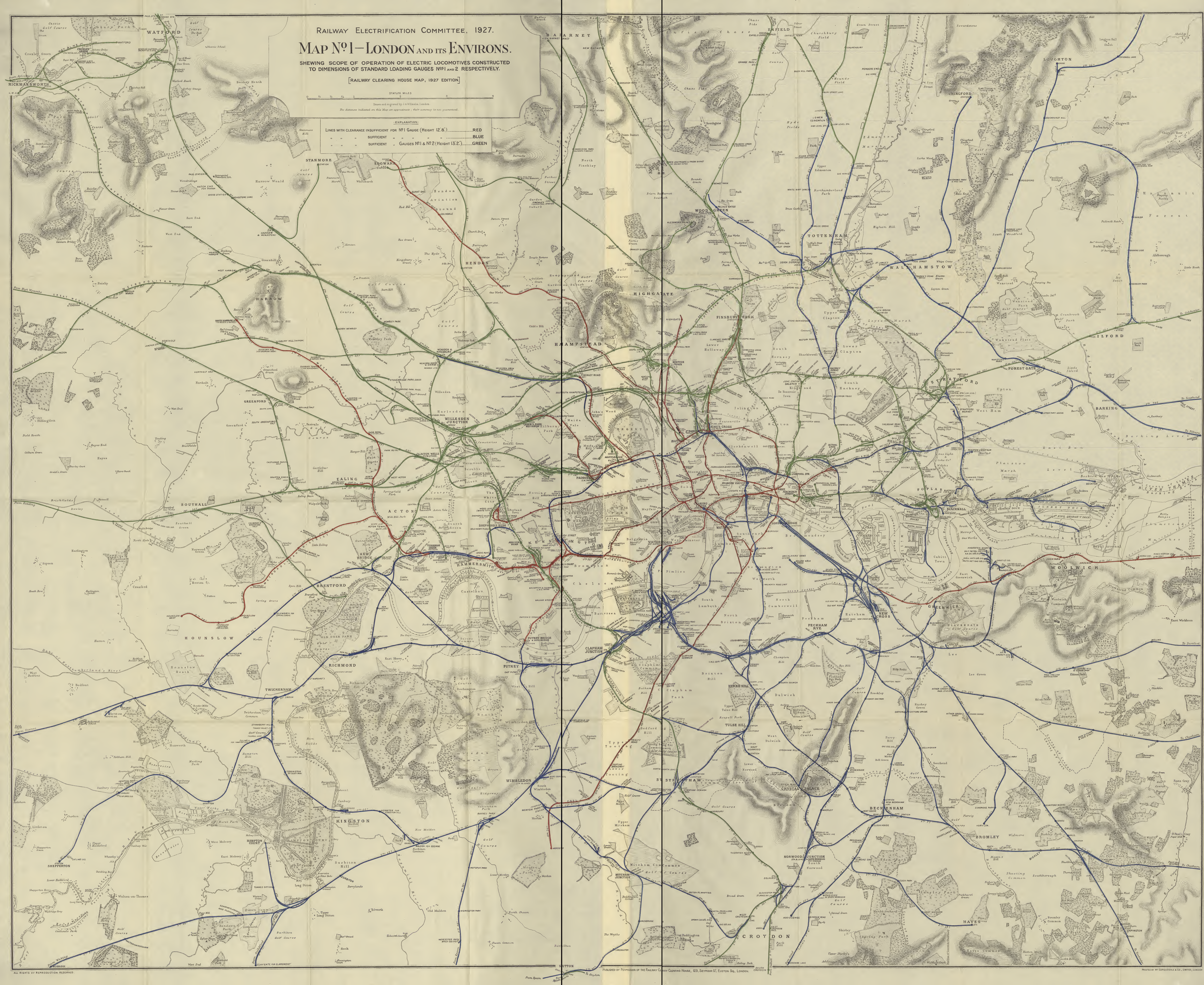
SHEWING SCOPE OF OPERATION OF ELECTRIC LOCOMOTIVES CONSTRUCTED TO DIMENSIONS OF STANDARD LOADING GAUGES NOS 1 AND 2 RESPECTIVELY.

[RAILWAY CLEARING HOUSE MAP, 1927 EDITION.]



Drawn and engraved by J. A. W. Emslie, London.

								- EXPLANATION -	
LINES WITH CLEARANCE INSUFFICIENT FOR N°1 GAUGE (HEIGHT 12'8").....								RED	
" " " SUFFICIENT " " " " " "								BLUE	
" " " SUFFICIENT " GAUGES N°1 & N°2 (HEIGHT 13'2").....								GREEN	



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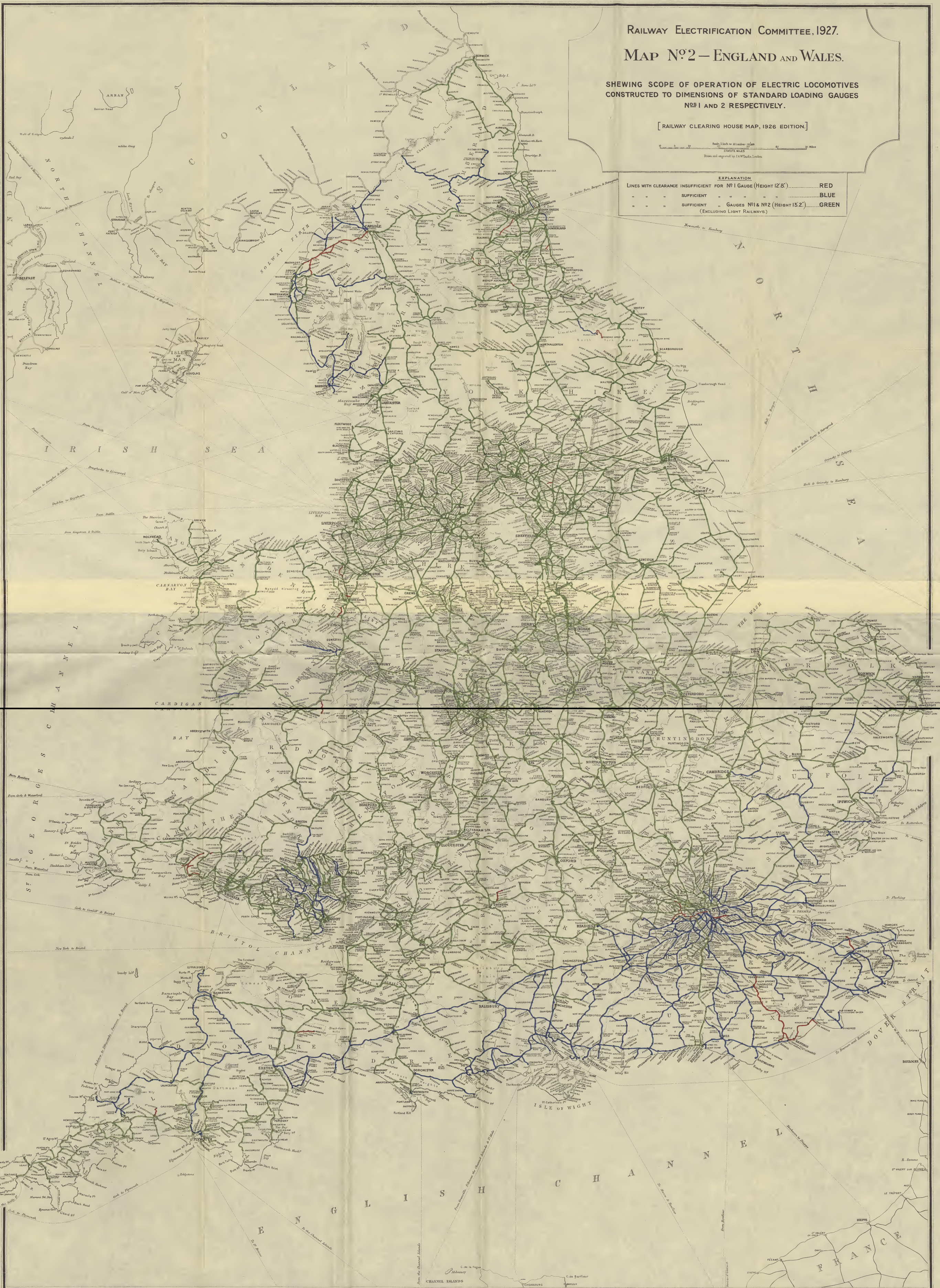


MAP N^o 2—ENGLAND AND WALES.

[RAILWAY CLEARING HOUSE MAP, 1926 EDITION.]

Scale, 1 inch to 11 miles - $\frac{1}{11}$ inch
0 5 10 15 20 25 30 35 40 45 50 M
STATUTE MILES
Drawn and engraved by J. & W. Esdaile, London.

EXPLANATION		
LINES WITH CLEARANCE INSUFFICIENT FOR NO. 1 GAUGE (HEIGHT 12'8")		RED
" " " SUFFICIENT " " " "		BLUE
" " " SUFFICIENT " " GAUGES NO. 1 & NO. 2 (HEIGHT 13'2")		GREEN
(EXCLUDING LIGHT RAILWAYS.)		



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MAP N^o 3—SCOTLAND.

[RAILWAY CLEARING HOUSE MAP, 1927 EDITION.]

Scale, 1 inch to $7\frac{1}{2}$ miles - 47 $\frac{1}{2}$ 000.

rawn and engraved by J.&W. Emshie, London.

EXPLANATION.					
LINES WITH CLEARANCE INSUFFICIENT FOR NO. 1 GAUGE (HEIGHT 12'8").....					RED
" " " SUFFICIENT " " " " " " " " " " " " " " " "					BLUE
[EXCLUDING LIGHT RAILWAYS.]					



